Appendix H

Field Artillery Radar Support Requirements

TA radars will often be widely dispersed across the battlefield and require support from units that may not be familiar with radar support requirements. This appendix outlines the major support requirements for TA radars.

SURVEY

Common datum/common survey is critical for successful employment of TA assets as well as all other battlefield operating systems. The specific survey data required for each TA radar system is described below.

- AN/TPQ-36:
  - Grid zone.
  - Site location (universal transverse mercator (UTM) coordinates within 10 meters CEP).
  - Distance from near stake (radar location) to far stake (orienting point). This distance should be at least 250 meters. The minimum distance is 100 meters. However the further out the distance the better the accuracy that the system will report.
  - Azimuth from near stake to far stake (0.4 mil probable error (PE)).
  - Vertical angle from near stake to far stake (0.5 mil PE).
  - Altitude of the near stake (10 meters PE).
- AN/TPQ-37:
  - Grid zone.
  - Site location (UTM coordinates within 10 meters CEP).
  - Distance from near stake (radar location) to far stake (orienting point). This distance should be at least 250 meters. The minimum distance is 100 meters. However, the further the distance the better the accuracy that the system will report.
  - Azimuth from near stake to far stake (0.4 mil PE).
  - Altitude of the near stake (3 meters PE).

MODULAR AZIMUTH POSITIONING SYSTEM

The AN/TPQ-36(V)8 and AN/TPQ-37(V)8 radars are equipped with the Modular Azimuth Positioning System (MAPS). MAPS provides required survey for Firefinder systems. However, MAPS requires external survey support to provide the initialization data and update points required for operation. MAPS initialization requires the use of an initial survey control point of 5th order or higher. Before MAPS can be initialized, the ATG must be parked over the survey control point. Once initialization begins it takes between 9 and 15 minutes to complete. Once the initialization data is stored,

the ATG can be moved to a different location in preparation for operations. The MAPS can be turned off after initialization and as long as the ATG is not moved it will maintain all data. MAPS must be turned on and operational before the ATG can be moved.

COMMUNICATIONS

Firefinder radars use voice and digital communications to communicate with the supported unit. The primary method of communications is always digital. Radar acquisitions and mission data are transmitted digitally to the supported FDC or controlling headquarters for receipt by IFSAS, AFATDS, BCS or FDS.

The use of wire enhances communication responsiveness, security, minimizes the effects of jamming, and minimizes the possibility of enemy intercept by radio direction finders. The supported unit is responsible for providing and installing wire. Nonetheless, the use of wire may be impractical in situations requiring frequent moves or widely dispersed positions. FM radio becomes the primary means of communication in these situations.

The enemy situation must be considered when planning and conducting communications. Enemy EW capabilities may dictate changes in normal radar communication procedures.

COMMUNICATION NETS

The AN/TPQ-36 section normally operates in a battalion operations/fire net digitally and a command net for voice communications. Usually, these two nets belong to the supported DS battalion. However, these operating nets may be modified by individual units depending on command instruction and SOP.

The AN/TPQ-37 section normally operates on the TA/intel net digitally and a command net for voice communications. The AN/TPQ-37 usually is under the control of the DIVARTY or FA brigade TOC and passes target information directly to the counterfire officer at the controlling TOC. The radar may also be directed to pass targets to a DS or GS FA battalion. In such cases, the supported unit must provide all communications data. This includes signal operating instructions (SOIs).

DIGITAL COMMUNICATIONS

Digital communications addresses and authentication codes are prescribed in current cryptographic and authentication manuals. If digital communications are not available, the radar operator uses standard voice procedures to pass target information over the DS battalion operations/fire net or the force artillery command/fire net to the supported unit FDC.

Firefinder radar systems interface digitally with IFSAS, AFATDS, BCS, and FDS. Computer data needed for interface are input during initialization and can be changed by use of function codes or functional displays depending on the version of the system control shelter.

The digital messages used by Firefinder radars are divided into two groups - receive messages and transmit messages. Messages are displayed according to the priority level of the message. There are three priority levels for messages - 1 (highest), 2, and 3 (lowest). See the digital message format table for a display of which messages are received and/or transmitted.

The Firefinder radar can store net member data (member identifications and unit types) for up to ten receivers of various types. These receivers include:

- TACFIRE/IFSAS/AFATDS
- BCS (Battery Computer System)
- MLRS (Multiple-Launch Rocket System)
- FF (Firefinder)
- PALADIN (Howitzer system)

Firefinder radars can communicate digitally with any of the receivers listed above. However, only one net member at a time may be selected for communications.

Table H-1. Digital Message Formats

MESSAGE TYPE	TRANSMITT / RECIEVE	FORMAT NAME	PRIORITY
Priority/Censor Zone	R	SPRT;FILTER	3
Radar Search Area	R	SPRT;SEARCH	3
MET Data	R	MET;TA	3
Radar Location	T/R	FM;OBCO	3
Friendly Fire Battery	R	FM;INTM	2
Friendly Fire Target	R	FM;MTO	2
Radar Ready/Registration	T/R	FM;SUBS	2
Fire Mission	T/R	FM;FOCMD	1
Priority target report	T	FM;CFF	1
Target report	T	ATI;CDR	3
Free Text	T/R	SYS;PTM	1

MESSAGE TYPE	TRANSMITT / RECIEVE	FORMAT NAME	PRIORITY
Communication Test	T/R	MD;XMT5	3
Datum Report	T	SPRT;DATUM	3

NOTE: The Firefinder radar is able to communicate with other digital devices. However it is still limited to 35 characters in the free text message format.

VOICE COMMUNICATIONS

When digital communications are not possible, the radar section must report targets by voice. A target that would normally be sent digitally in FM;CFF format will be sent as a voice call for fire. The radar section should initiate a fire-for-effect mission with the supported FDC. The call for fire contains six elements. These elements are listed below in the order in which they are used. For a detailed explanation of each element, see FM 3-09.30 (6-30).

- Observer identification (or radar call sign).
- Warning order (for example, fire for effect).
- Target location (grid of target).
- Target description (for example, enemy artillery).
- Method of engagement.
- Method of fire and control.

Although direction is not one of the six elements of the call for fire, it is transmitted by the radar section as part of the initial call for fire. Radar observer direction is always reported as 6400 mils.

COMMUNICATIONS EQUIPMENT

Each radar section operates in two tactical FM radio nets as directed by the controlling headquarters. Two AN/VRC-92A radios are available for this purpose. These radios are equipped with speech secure devices for secure voice transmissions. The radar section also has radio equipment in the command/reconnaissance vehicle; however, the unit TOE will determine the types and quantities. In addition, some sections are equipped with an EPLRS. EPLRS provides near real time, jam resistant, secure data distribution and communications, identification, position location, navigation aid, and automatic reporting for tactical forces.

ADMINISTRATION

When the radar section is attached to a unit, the unit of attachment is responsible for providing routine personnel and administrative support. The radar section's parent unit forwards mail, pay, and routine distribution to the unit of attachment's headquarters for distribution to the radar section.

MESS

The unit to which the radar is attached supports the section with rations and water.

MAINTENANCE

NON-RADAR MAINTENANCE

The supported unit provides organizational and direct support maintenance of all non-radar specific equipment.

RADAR-SPECIFIC MAINTENANCE

FA radar systems are maintained at four maintenance levels, operator/crew, organizational, direct support, and depot.

Unit-Level Maintenance

Unit maintenance consists of operator performed scheduled preventive maintenance checks and services (PMCS) and organizational level scheduled and unscheduled maintenance as prescribed by the maintenance allocation chart. Each radar section should have on hand the parts authorized by the mandatory parts list to perform organizational and direct support maintenance. These parts are mandatory and do not require demand support. The radar repairer (MOS 35M) is responsible for performing organizational and direct support maintenance and the supervision of operator performed PMCS. The 35M is also responsible for identifying equipment faults that require higher-level maintenance. The radar section leader performs supervisory maintenance tasks.

The radar repairer is responsible for requesting depot maintenance under supervision of the radar section leader. These requests go through the controlling unit headquarters.

The radar repairer (35M) from the radar section performs selected tests and repairs and replaces components. He has a complete set of tools, test equipment, and repair parts at his disposal. If on-site repairs cannot be made, the radar will be evacuated to a rear location for major repairs. In addition to the section radar repairer, each TAB and CTAD has a radar repairer and DS-level test, measurement, and diagnostic equipment (TMDE) to isolate DS-level faults to facilitate repair of Firefinder radars.

Depot Maintenance

The depot can completely overhaul and recondition major end items and assemblies that are beyond the capabilities of field maintenance units. The appointed depot for Firefinder is Tobyhanna Army Depot.

Repair Parts

The logistics concept for FA radar systems does not place any unusual demands on the supply system. The MPL governs the supply of Firefinder peculiar items. Each radar section deploys with its MPL. The supported unit

provides common expendables and the parent unit forwards system-peculiar expendables to the section on an as required basis.

SECURITY

Because of its small size, the FA radar section cannot provide its own security in a tactical situation. For this reason, the radar section must fall under the security of an adjacent unit or be augmented with personnel and weapon systems to provide security. Similarly, when deployed, the section cannot perform other security or administrative functions, such as forming NBC or crater analysis teams. The deployed section falls under the responsibility of the supported unit for these functions.

PETROLEUM, OILS, AND LUBRICANTS

The supported FA unit supplies Class III petroleum products to the radar section as part of its normal petroleum, oils, and lubricants (POL) distribution process. The supported unit must understand the fuel consumption rates for radar systems so their fuel requirements can be incorporated in supported unit's logistics plan. The consumption rates for Q-36 and Q-37 are:

- AN/TPQ 36 Generator Set MEP 813A.
  - Fuel consumption. 1.07 gallons per hour.
  - Fuel capacity. 12.5 gallons (DF-1,DF-2, DF-A, JP4, JP5 or JP8).
- AN/TPQ 37 Generator Set MEP-816A.
  - Fuel consumption. 5.37 gallons per hour.
  - Fuel capacity. 43 gallons (DF-1,DF-2, DF-A, JP4, JP5 or JP8).

METEOROLOGICAL DATA

MET data are crucial to the accuracy of hostile weapon location and friendly fire data. The MET parameters entered during radar initialization affect radar performance by correcting for atmospheric refraction. They are also important in estimating the effect of wind, temperature, and density on the projectile's trajectory. However, the greatest effect on the accuracy of hostile and friendly weapon impact prediction is caused by wind.

The MET data required for the Q-36 and Q-37 differ in the MET data elements used by the radar. The Q-36 only uses wind speed and direction from the target acquisition MET whereas the Q-37 requires relative humidity and temperature from the target acquisition MET along with barometric pressure from the computer MET.

Digital MET messages are transmitted to the radar using the MET;TA and MET;CM message formats. Data elements used by the radar are:

- Relative humidity (RH)(Q-37 only).
- Temperature in degrees Kelvin (Q-37 only).
- Barometric pressure in millibars (Q-37 only).
- Altitude of MET data station.
- Wind speed (must be entered when greater than 20 knots).

- Wind direction in mils.

Current software extrapolates temperature, pressure, and relative humidity back to the radar's altitude assuming the standard atmospheric lapse rate and constant relative humidity. However, the most accurate correction for refraction is obtained from the temperature and relative humidity measured at the surface as near the radar as possible. Therefore, the header and line 00 of the most current target acquisition MET message should be used to obtain temperature and relative humidity. The wind speed and direction should also be taken from the target acquisition MET. The MET line used for wind speed and direction is determined by the altitude of the radar and the altitude of the expected detection area based on screening crest, and the difference between the radar and MET station altitudes. Generally speaking, the line used should provide the wind speed and direction approximately 1000 meters above the radar altitude. Barometric pressure is also required. This comes from the corresponding computer MET. The line used from the computer MET must correspond to the same altitude as the line used from the target acquisition MET. For example: if you use line 11 of the target acquisition MET (900 to 1000 meters), you would then use line 3 of the computer MET (1000 meters). See Table H-2.

Table H-2. MET Altitude Comparison

Line Number	Computer MET Altitude	TA MET Mdp Altitude	TA MET Altitude Range
00	MET Station Alt.	MET Station Alt	MET Station Alt
01	200	25	0/50
02	500	75	50/100
03	1000	150	100/200
04	1500	250	200/300
05	2000	350	300/400
06	2500	450	400/500
07	3000	550	500/600
08	3500	650	600/700
09	4000	750	700/800
10	4500	850	800/900

Line Number	Computer MET Altitude	TA MET Mdp Altitude	TA MET Altitude Range
11	5000	950	900/1000
12	6000	1050	1000/1100
13	7000	1150	1100/1200
14	8000	1250	1200/1300
15	9000	1350	1300/1400
16	10000	1450	1400/1500
17	11000	1550	1500/1600
18	12000	1650	1600/1700
19	13000	1750	1700/1800
20	14000	1850	1800/1900
21	15000	1950	1900/2000
22	16000	2050	2000/2100
23	17000	2150	2100/2200
24	18000	2250	2200/2300
25	19000	2350	2300/2400
26	20000	2450	2400/2500
27	NA	2550	2500/2600

It is also necessary to determine the MET station altitude. This can be determined from the header line of either the target acquisition MET or the computer MET. Station height in the header of both MET messages is entered in tens of meters and is equal to altitude. Figure H-1 shows the header line of the computer MET message.

COMPUTER MET MESSAGE For use of this form, see FM 6-15; the proponent agency is TRADOC.								
IDENTIFI- CATION	OCTANT	LOCATION $L_aL_aL_a$ or	 $L_oL_oL_o$ or	DATE	TIME (GMT)	DURATION (HOURS)	STATION HEIGHT (10s M)	MDP PRESSURE MB
METCM	Q	xxx	xxx	YY	$G_oG_oG_o$	G	hhh	$P_dP_dP_d$
METCM	1	347	984	25	138	0	036	974

		ZONE VALUES			
ZONE HEIGHTS METERS	LINE NUMBER	WIND DIRECTION (10s M)	WIND SPEED (KNOTS)	TEMPERATURE (1/10°K)	PRESSURE (MILLIBARS)
	ZZ	ddd	FFF	TTTT	PPPP
SURFACE	00	310	004	2923	0974
200	01	250	011	2931	0962

Figure H-1. Identification line

COMPUTER MET

The following paragraphs explain the entries in the computer MET message. Refer to figure H-1.

- Identification Line. The ID line is arranged in four six-digit groups. Thus the symbols for the ID line are METCMQ, $L_aL_aL_aL_oL_oL_o$, $YYG_oG_oG_oG$, and $hhhP_dP_dP_d$. The ID line is shown in Figure H-1.
  - Group 1. Group 1 consists of METCMQ. The symbol METCM is placed at the beginning of each computer MET message. This symbol indicates that it is a MET message and that it contains computer-type MET data. The digit under the symbol Q represents the global octant in which the MET section is located. For convenience in determining the geographical location of the reporting MET section, the globe was divided into octants numbered 0 through 8.
  - Group 2. Group 2 consists of $L_aL_aL_aL_oL_oL_o$ or XXXXXX. These six spaces are used to specify the location to the nearest tenth of a degree. The symbol $L_aL_aL_a$ represents the latitude to the nearest tenth of a degree. The symbol $L_oL_oL_o$ represents the longitude to

the nearest tenth of a degree. When the longitude is over 100°, the first digit is dropped. The XXXXXX is used to signify standard six digit grid coordinates.

  - Group 3. Group 3 consists of $YYG_oG_oG_oG$. The symbol YY represents two digits for reporting the Greenwich date of the observation on which the message is based. The Greenwich date may differ from the local date, depending on the location and the hour of the day. The symbol $G_oG_oG_o$ represents three digits for reporting hours in tens, units, and tenths of hours. The symbol G represents the duration of validity of the message in hours. US forces always enter 0 in the space under G since the period of validity is not predicted. Other NATO forces use digits 1 through 8 in this space. A code of 9 indicates a predicted validity of 12 hours.
  - Group 4. Group 4 consists of $hhhP_dP_dP_d$. The symbol hhh represents the MET station altitude in tens of meters above mean sea level. The symbol $P_dP_dP_d$ represents the surface pressure in millibars. When the surface pressure is 1,000 mb or higher, the first digit is dropped.

- Explanation. The identification line (for transmittal) is shown in Figure H-1 and explained as follows:
  - The METCM1 indicates a computer-type MET message and a station location in octant 1. (The only difference between a computer MET and a target acquisition MET identification line would be in this field. The target acquisition MET would read METTAQ).
  - The 347984 indicates station location at 34°42'N latitude and 98°24'W longitude.
  - The 251380 indicates the date of the message is the 25th day of the month, GMT date, at 1348, and it is from a US Army artillery MET section.
  - The 036974 indicates the station altitude is 360 meters above mean sea level and the surface pressure is 974 mb.
- Message Body. (METCM) The remaining lines of the computer MET message (ZZdddFFF TTTTPPPP) represent surface and zone MET data. The symbol ZZ represents the line number that identifies the reported MET information with the appropriate atmospheric layer. The line numbers begin with 00 (surface) and are numbered consecutively through line 26 (line 27 for the target acquisition MET). The symbol ddd represents the true direction from which the wind is blowing. The direction is reported in tens of mils. The symbol FFF represents the true wind speed in knots. The symbol TTTT represents the virtual temperature. This temperature is expressed to the nearest 0.1°K. The symbol PPPP represents the air pressure. This pressure is expressed to the nearest millibar. The lines of the computer MET message are encoded and transmitted in eight-digit groups with two groups for each line.

TARGET ACQUISITION MET

The header line of the target acquisition MET is nearly the same as the computer MET. The only difference is the first six characters will be METTAQ instead of METCMQ. The following paragraphs explain the rest of the entries in the target acquisition MET. Refer to Figure H-2.

MET;TA;_/_/_/__/___;Q:9;POSI:xxxxxx;DTI:YY/GG.G/V;HGT:HHH;ATMS:PPP;CMBRI:CCC/NNN;
LNA:ZZ/DDD/FFF/TTTT/UU/,ZZ/DDD/FFF/TTTT/UU/,ZZ/DDD/FFF/TTTT/UU;
LNB:ZZ/DDD/FFF/TTTT/UU/,ZZ/DDD/FFF/TTTT/UU/,ZZ/DDD/FFF/TTTT/UU;

Figure H-2. Target Acquisition MET

- Message Body (METTA). The remaining lines of the target acquisition MET consist of additional groups. In the target acquisition MET message zones are equal to lines in the computer MET message depicted in Figure H-1.
  - Group 5 consists of CCCNNN. The symbol CCC represents the height of the base of the lowest cloud at the point of observation. It is given in tens of meters and is not used by Firefinder. The symbol NNN represents mean refractive index at the surface in N units. If NNN is not to be included in the message, these missing data will be indicated by three slashes (///).
  - Group 6 consists of $Z_tZ_t$dddFFF. The symbol Z_tZ_t represents the zone number code. The symbol ddd represents the mean wind direction for the zone given in thousands, hundreds, and tens of mils. For zone number 00, the value is the wind direction at the MET section location. The symbol FFF represents the mean wind speed of the zone in hundreds, tens, and units of knots. For zone number 00, the value is the wind speed at surface.
  - Group 7. This group consists of ttttUU. The symbol tttt represents the mean air temperature of the zone in hundreds, tens, units, and tenths of a degree Kelvin. For zone number 00, the value is the air temperature at surface. The symbol UU represents the mean RH expressed as a percentage in tens and units. A mean RH of 100 percent is denoted by 00.
  - Group 8. Group 8 consists of 99999. This group is a message terminator. It is used only when the message is transmitted by telegraphic means.

For additional information on the atmospheric structure of MET messages and an in-depth explanation of header and data lines of the MET;TA and MET;CM messages see FM 3-09.15 (6-15), Field Artillery Meteorology.